



Building America: Research for Real World Results

ERIC WERLING

Building America Program Coordinator
Building Technology Office

- Homebuilders Didn't Innovate
- “Consumers Won't Pay for Energy Efficiency”
- Renewable Energy Isn't “Cost Effective”

- **Pace of Innovation is picking up**



ADVANCED TECHNOLOGIES



**Building
Science Solutions**

**Energy Efficient
Components**

**Assured Health
and Safety**

HOUSE-AS-A-SYSTEM BUSINESS CASE



**New Homes
with Whole-House
Packages**

**Existing
Homes with Whole-
House Packages**

**Whole-House
Program Support**

EFFECTIVE GUIDANCE AND TOOLS



**High
Performance
Home Solutions**

**High
Performance
Home Metrics**

**Research
Tools**

INFRASTRUCTURE DEVELOPMENT



**Educating
Professionals**

**Recognizing
Value in
Transaction Process**

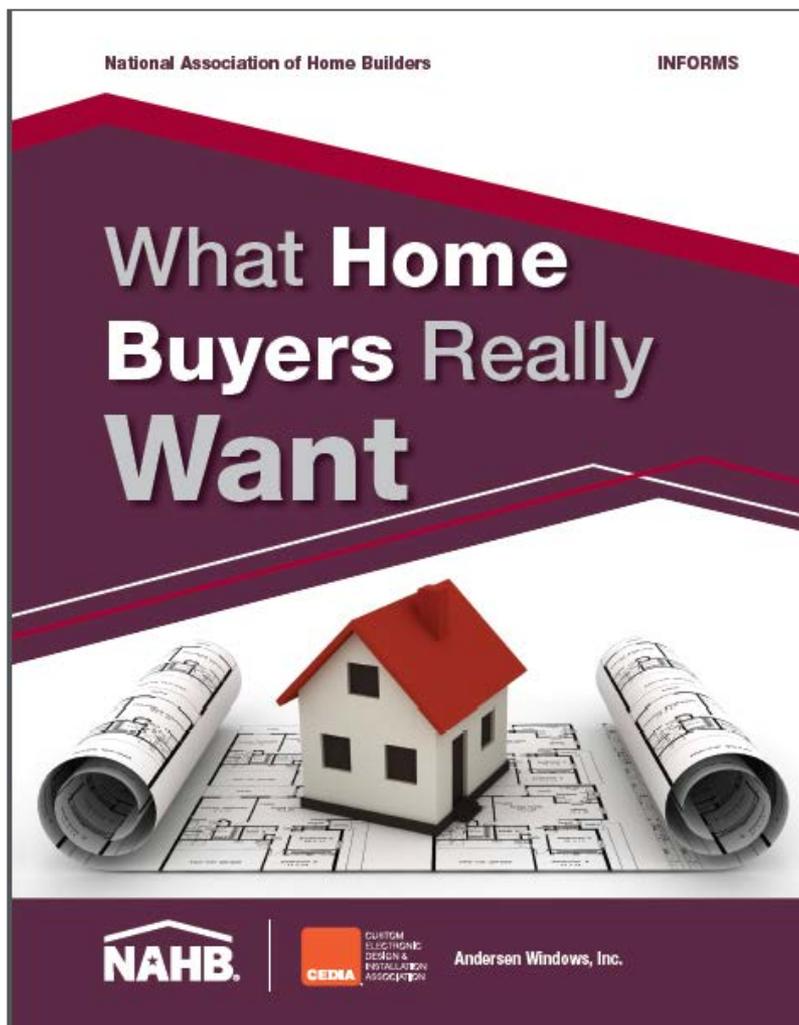
**Informing
Codes and
Standards**

- Pace of Innovation is picking up

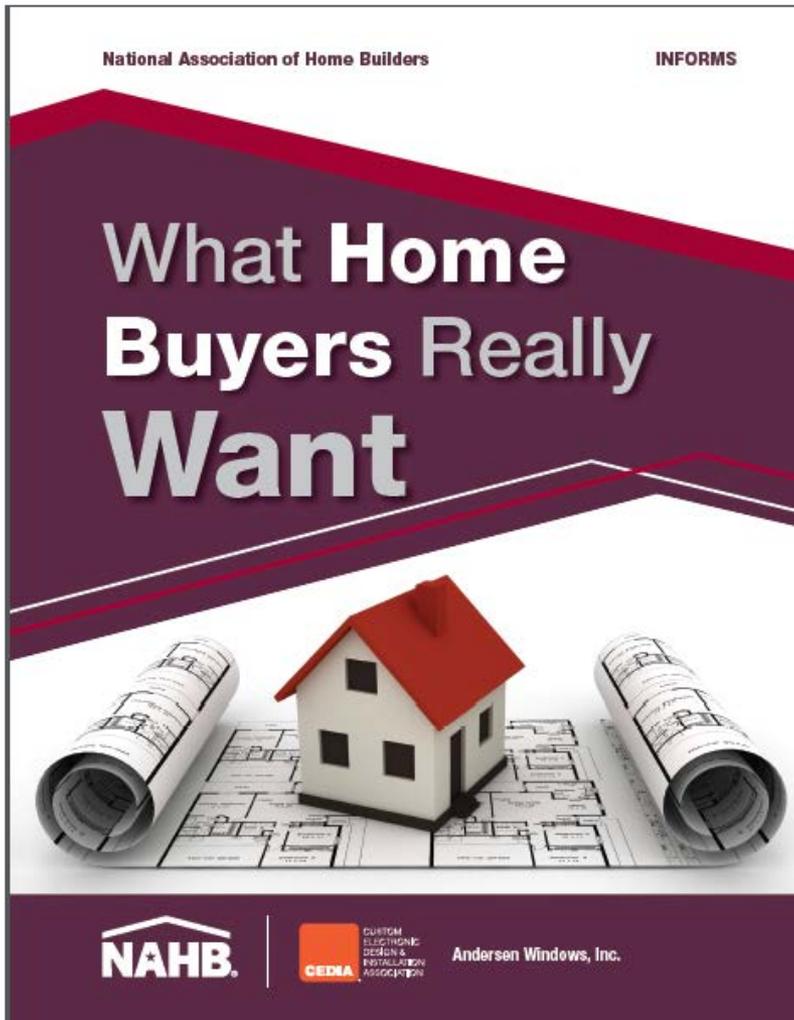


- Consumers are now demanding “Green” and energy efficiency





“Most buyers want an energy efficient home, and on average would pay an additional \$7,100 up front if it would save them \$1,000 a year in utility costs.”



Of more than **120 features** rated as “essential/must have,” “desirable,” “indifferent,” or “do not want,” a total of **11 are wanted** (i.e. rated essential or desirable) **by 85 percent or more of home buyers**. This “most wanted” list includes **three features dealing with Energy-star ratings**, two in the kitchen, and two in the bathroom. Energy-star rated appliances appear at the top, followed closely by the laundry room.

- Pace of Innovation is picking up



- Consumers are now demanding “Green” and energy efficiency



...



- PV costs are going down fast



>half way to 2020 goal

We Are On The Path To ...

U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy



Zero Energy Homes (New and Existing)



- **Net Zero Homes** become common place
- Builders offer extended **Warranties** (>30 years)
- All housing **Trades offer Energy Efficiency** services
- “**House Doctor**” businesses emerge
- **Home Asset Management** businesses emerge
- Americans pay for **Preventative Maintenance** for their Homes

~\$2,200: Average Annual Household Energy Bill

>113,000,000: Housing Units in America

>\$240 Billion: Amount spent on home utility bills per year.

if we make our houses **50%** more efficient

>\$120 Billion: Available to the economy

- **>100 Million Homes**
- **Jobs** (millions of U.S. housing jobs)
- **Energy Independence** (NZE Homes use No foreign energy)
- **Clean Air & Healthier Households** (we spend >60% indoors)

How Can Uncle Sam Help?

Innovation Pipeline	Guidance & Tools	Improved Infrastructure	Market Recognition
Building America R&D Roadmap	Building America Solution Center	Building Science Education	Zero Energy Ready Homes
New Construction	Program Specifications	Sales Communication	Student Design Competition
Existing Home Improvement	Risk Management Tools	Market Valuation	Partner Recognition
		Codes & Standards	



How Can Uncle Sam Help?

Innovation Pipeline	Guidance & Tools	Improved Infrastructure	Market Recognition
Building America R&D Roadmap			
New Construction			
Existing Home Improvement			



- **New Homes Goal**

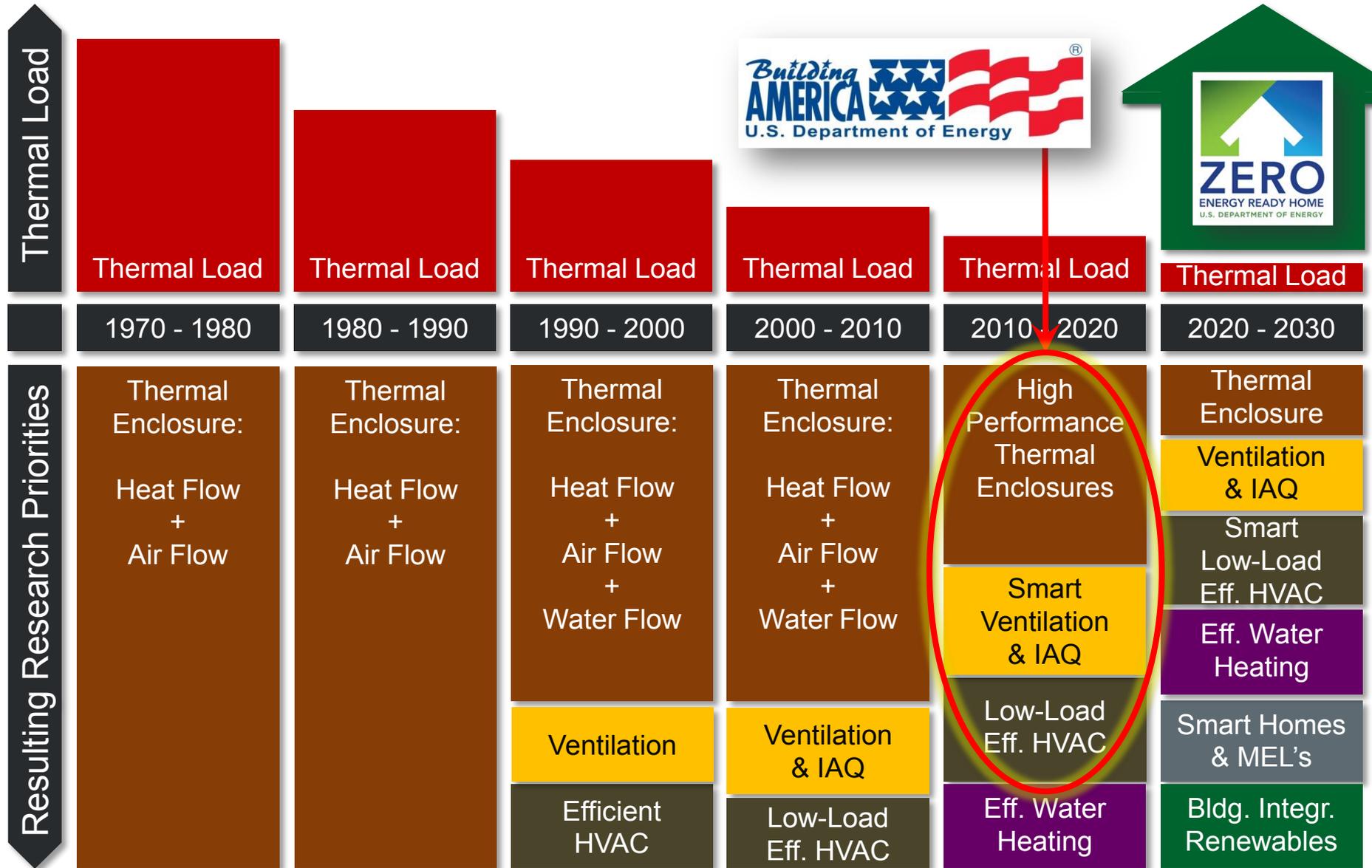
Demonstrate at scale market-relevant strategies for *new* homes offering savings of 50% or more by 2025

- **Existing Homes Goal**

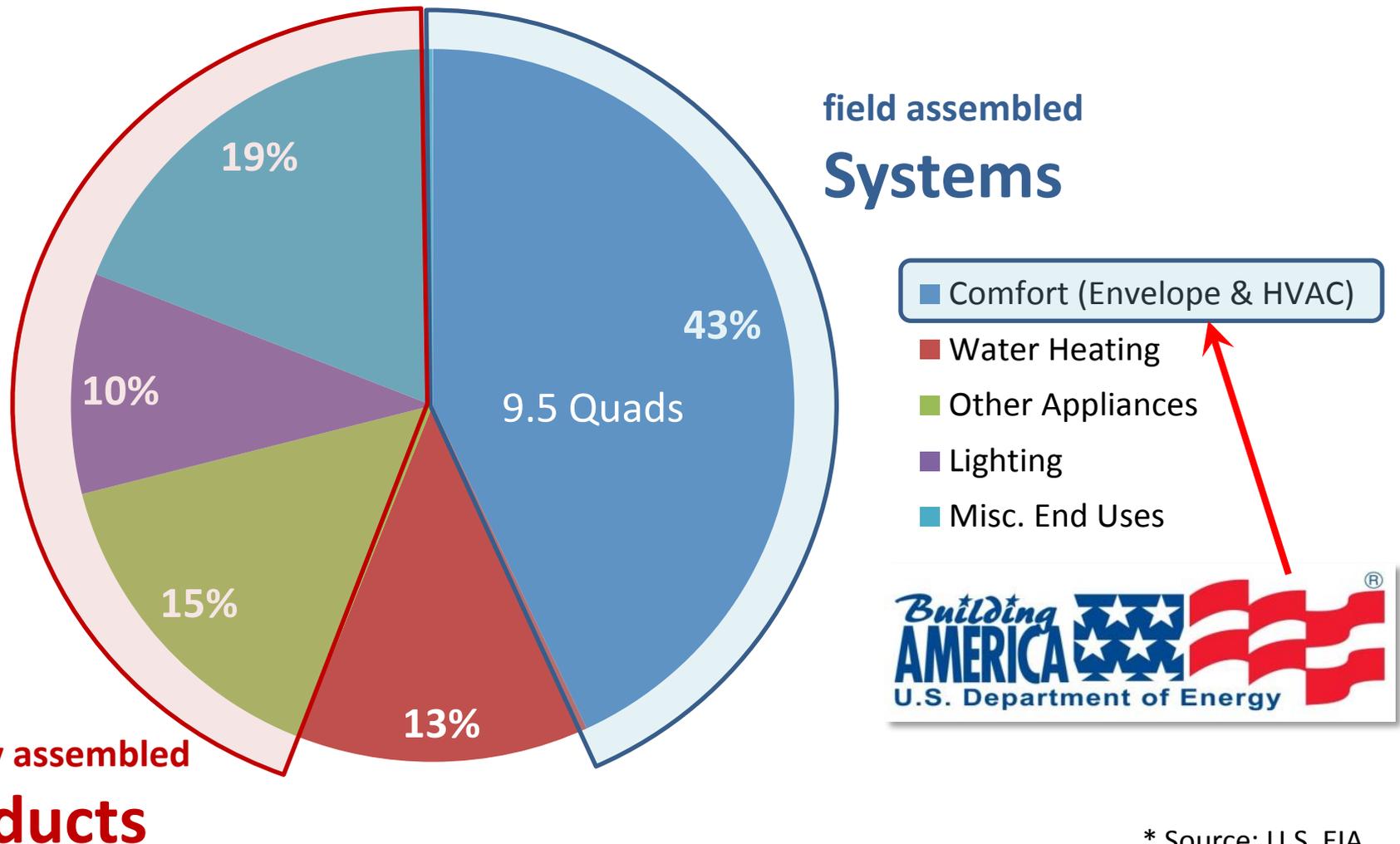
Demonstrate at scale market-relevant strategies offering existing home savings of:

- 20% or more by 2020
- 25% or more by 2025, and
- 40% or more by 2030

Building America R&D Roadmap



U.S. Residential Buildings Primary Energy Consumption (22 Quads)*



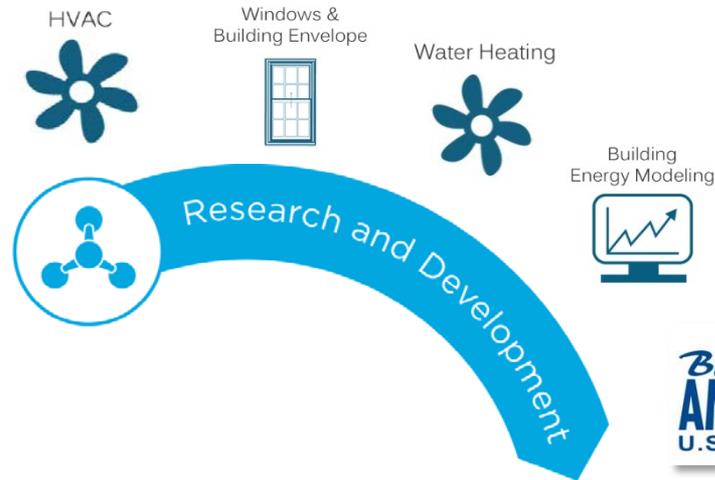
* Source: U.S. EIA



“v2”

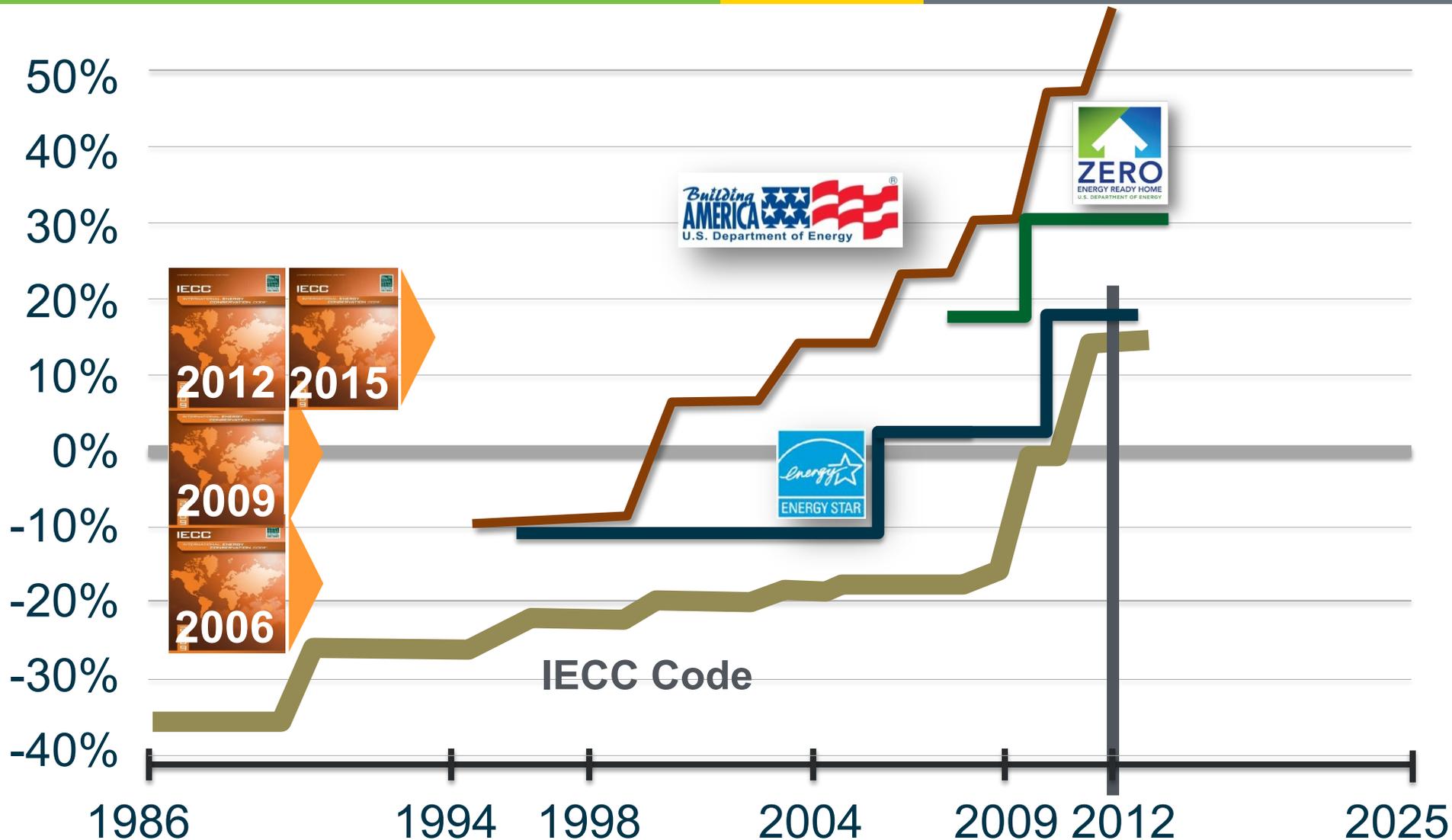
- Focused on reducing heating & cooling energy use in new & existing homes (highest impact end use)
- RD&D of low-risk, high performance envelopes, optimized HVAC systems, & IAQ solutions
- FY15-17 FOA's: new Building America Industry Teams will demonstrate solutions in real world houses
- New detailed strategic roadmaps will link Building America strategy to BTO Ecosystem
- Stakeholder Meetings will refine strategic roadmaps and leverage industry commitment for impact

BTO Ecosystem

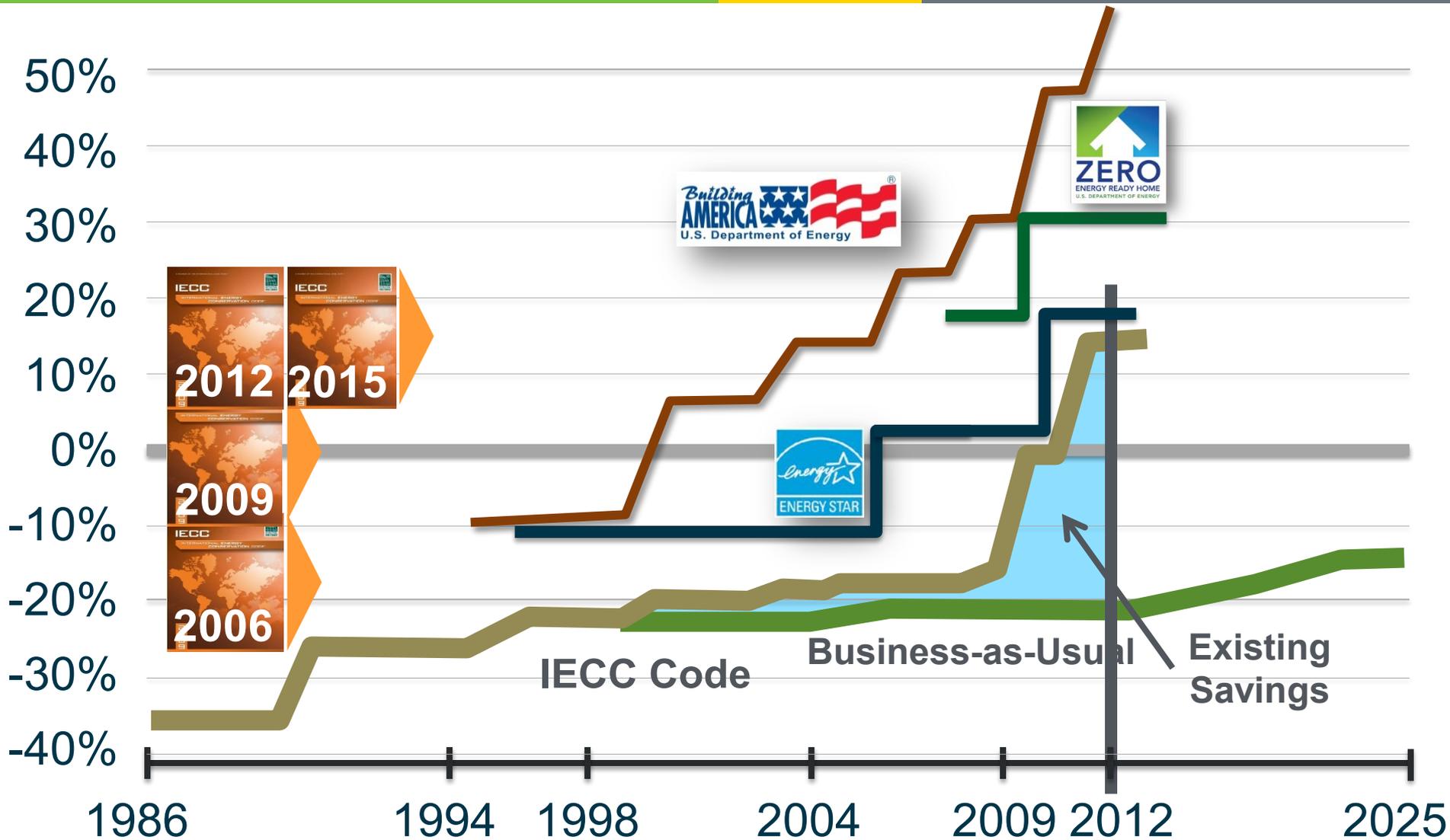


BTO Ecosystem

BTO Ecosystem in Action

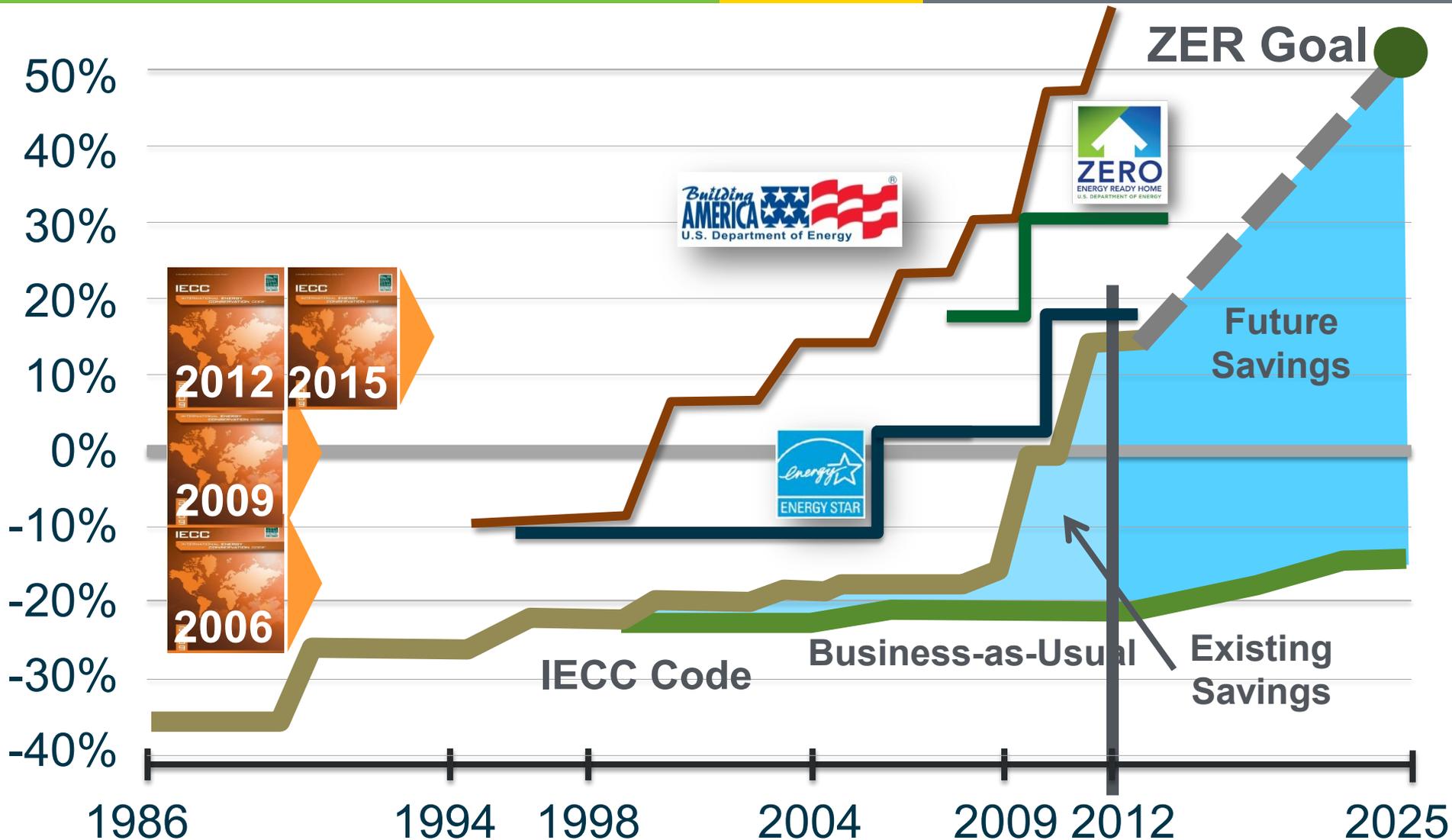


BTO Ecosystem in Action



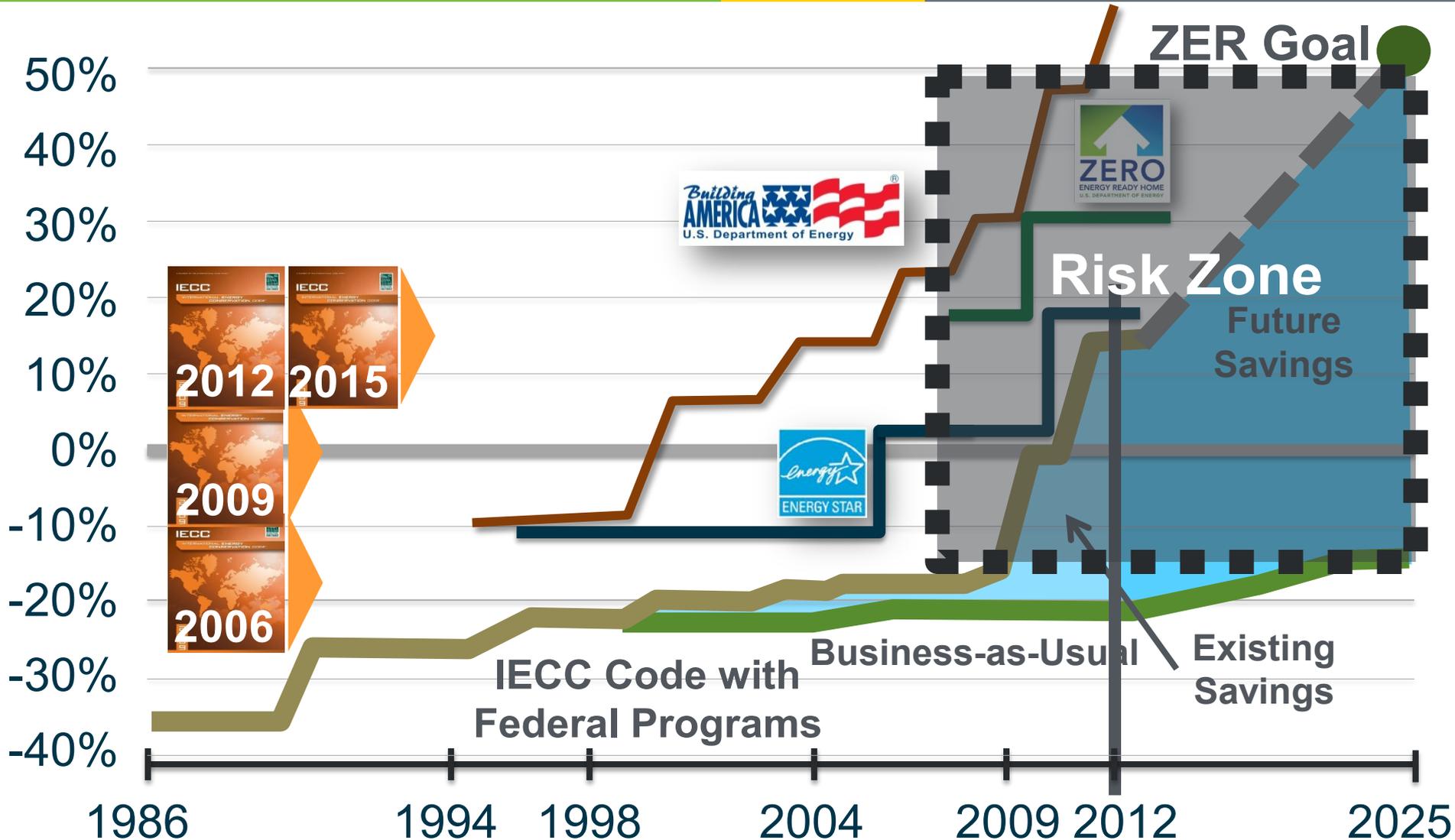
* Which ultimately sets the bar for future existing homes infrastructure

BTO Ecosystem in Action



* Which ultimately sets the bar for future existing homes infrastructure

But Wait!!



* Which ultimately sets the bar for future existing homes infrastructure

Energy Efficient New and Existing Homes...

- **Are More Likely to Stay Wet**
Increased insulation levels and air tightness can elevate risk of condensation and substantially limit drying potential inside building assemblies
- **Have Lower Airflow & Higher Indoor RH**
Lower loads reduce air flow, increase latent load, extend swing seasons
- **Need Assured Adequate Fresh Air**
Added air tightness demands improved source control, dilution, and filtration

If these performance issues are not solved, energy efficient homes will have comfort and durability problems, builders will not go further than current code, and future energy code advancement will be prevented.

Energy Efficient New and Existing Homes with ...

Moisture Managed High-R Envelopes

- Are Less Likely to Stay Wet

High performance homes with increased insulation, reduced infiltration, reduced risk of condensation, & adequate drying potential inside building assemblies

Optimized Low-Load Comfort Solutions

- Effectively Manage Airflow & Indoor RH for Comfort

High efficiency comfort systems for homes with low thermal loads, including optimal efficiency, managed air flow and RH control at all part load conditions

Smarter Indoor Air Quality Solutions

- Control Fresh Air Supply & Contaminant Removal

Added tightness with improved source control, dilution, and high efficiency filtration, with little or no energy penalty

A. HIGH PERFORMANCE, MOISTURE MANAGED ENVELOPE SOLUTIONS

High-R assemblies are the largest potential home energy saving measures (heating & cooling loads are nearly 50% of home energy use). But high-R without assured performance increases moisture risk. Current solutions are expensive or unfamiliar to industry and some solutions are limited by IRC code barriers (fire, structural).



STRATEGIC ROADMAPS

I. Envelope System Moisture Risk Management

II. High Performance Envelope Solutions

Roadmap Objectives:

- Codes and standard practice as endpoints
- Tools & guidance to help industry manage risks & minimize problems of adoption for high performance envelopes
- Address optimal performance, cost-effectiveness, & buildability
- Address codes & standard barriers to adoption of high performance envelope systems in new and existing homes

B. OPTIMAL COMFORT SYSTEMS FOR LOW LOAD HOMES

Installed performance of HVAC systems, especially distribution system effects and latent performance, is typically sub-optimal, which is a critical risk in low-load homes; duct system & RH optimization are not “owned” by manufacturers or required by codes/standards, & current solutions are labor intensive and/or expensive.



STRATEGIC ROADMAPS

- I. Optimal HVAC System Design Standards
- II. HVAC Equipment Gaps for Low Load Homes

Roadmap Objectives:

- Industry Standards, Codes & New Technologies as Endpoints
- Priority Issues/Barriers to Address:
 - High performance HVAC system solutions needed for low load homes
 - HVAC system standards don't adequately address indoor RH and airflow
 - HVAC system design, installation and maintenance faults lead to 20-70% system degradation
 - Current state of the art design standards rarely used & labor intensive
 - HVAC performance measurement technology limited and expensive

C. OPTIMAL VENTILATION SYSTEMS & IAQ SOLUTIONS FOR LOW LOAD HOMES

Basic ventilation has become standard in some areas, but current solutions are limited (climate, controls, sources, costs) & standards do not help optimize either IAQ or energy performance; significant IAQ risks remain, especially in low-load homes & envelope retrofits.



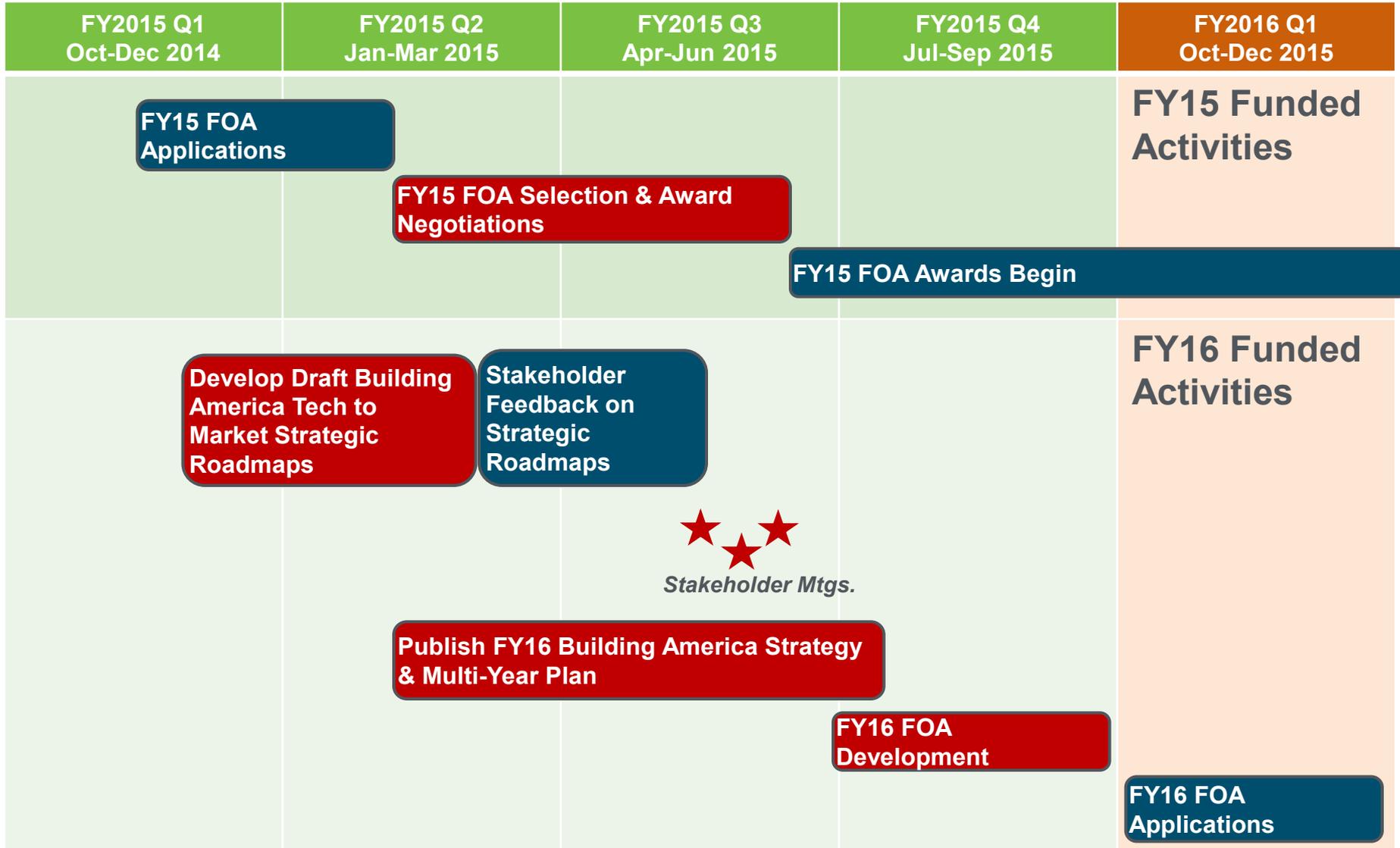
STRATEGIC ROADMAPS

- I. Targeted Pollutants/Non-Dilution Solutions
- II. Smart Ventilation Technology Solutions
- III. IAQ Valuation & Equivalence in Standards

Roadmap Objectives:

- Industry Standards, Codes & New Technologies as Endpoints
- Priority Issues to Address:
 - Health effects of PM2.5 exposure is high, while control technologies & standards are missing/limited (i.e., kitchen range hoods & advanced filtration)
 - Current state of the art ventilation technologies limited in flexibility for energy & DR management, do not adequately address RH & airflow, and are expensive
 - Combustion safety testing standards are expensive & can lead to both false negatives & false positives for health risks
 - Industry ventilation standard limited in flexibility, doesn't adequately address sources, RH & airflow, and is not universally adopted by building codes

FY16 Strategy Development Plan



Building America Planned FOA Schedule (subject to appropriations)

	FY2015				FY2016				FY2017				FY2018				FY2019			
Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
NREL contract down select (FY15 bridge-funding)	\$ High-R																			
	\$ Comfort																			
	\$ IAQ																			
	FOA15			FY15 FOA Award #1																
				FY15 FOA Award #2, etc.																
					FOA16			FY16 FOA Award #1												
				FY16 FOA Award #2																
				FY16 FOA Award #3, etc.																
									FOA17			FY17 FOA Award #1								
								FY17 FOA Award #2												
								FY17 FOA Award #3, etc.												

Notes:

1. All FOA's are fully funded up front
2. No. of awards each year will depend on award negotiations and budget.

How Can Uncle Sam Help?

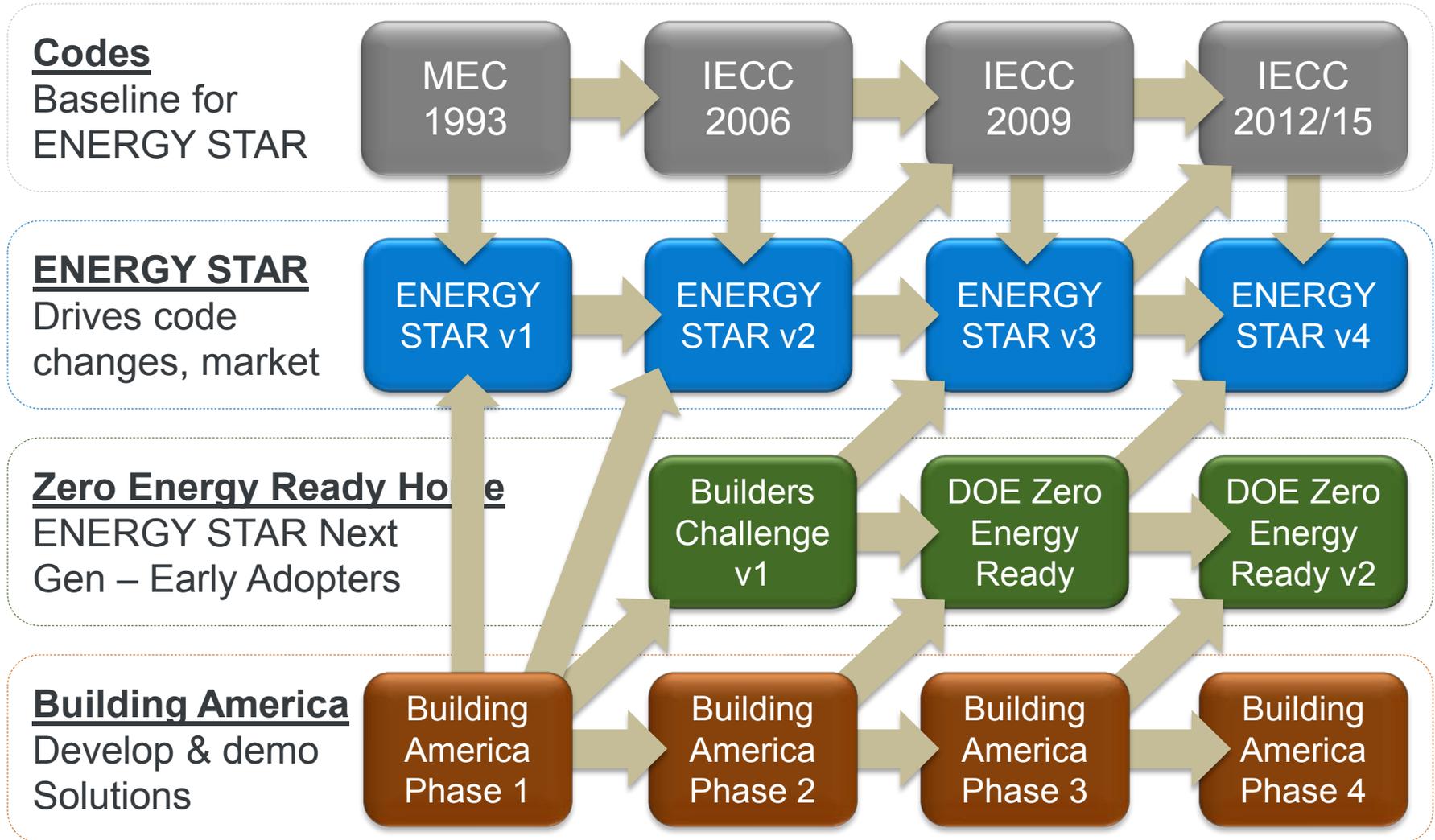
Innovation Pipeline	Guidance & Tools	Improved Infrastructure	Market Recognition
Building America R&D Roadmap			
New Construction			
Existing Home Improvement			





- **Emerging Technologies** & manufacturers develop advanced materials and component technologies
- **Appliance Standards** increase required efficiency for major home equipment
- **Building America** demonstrates early adoption of optimized integrated systems (i.e., Envelope & HVAC), using market ready technology
- Energy Star & **Zero Energy Ready Home** programs accelerate adoption, through market stimulation
- **Building Energy Code** advancement locks in proven whole house savings at scale

A Market Transformation System





Optimized Enclosure



Risk Management:

Optimized Comfort System
Complete Water Protection
Comprehensive IAQ System



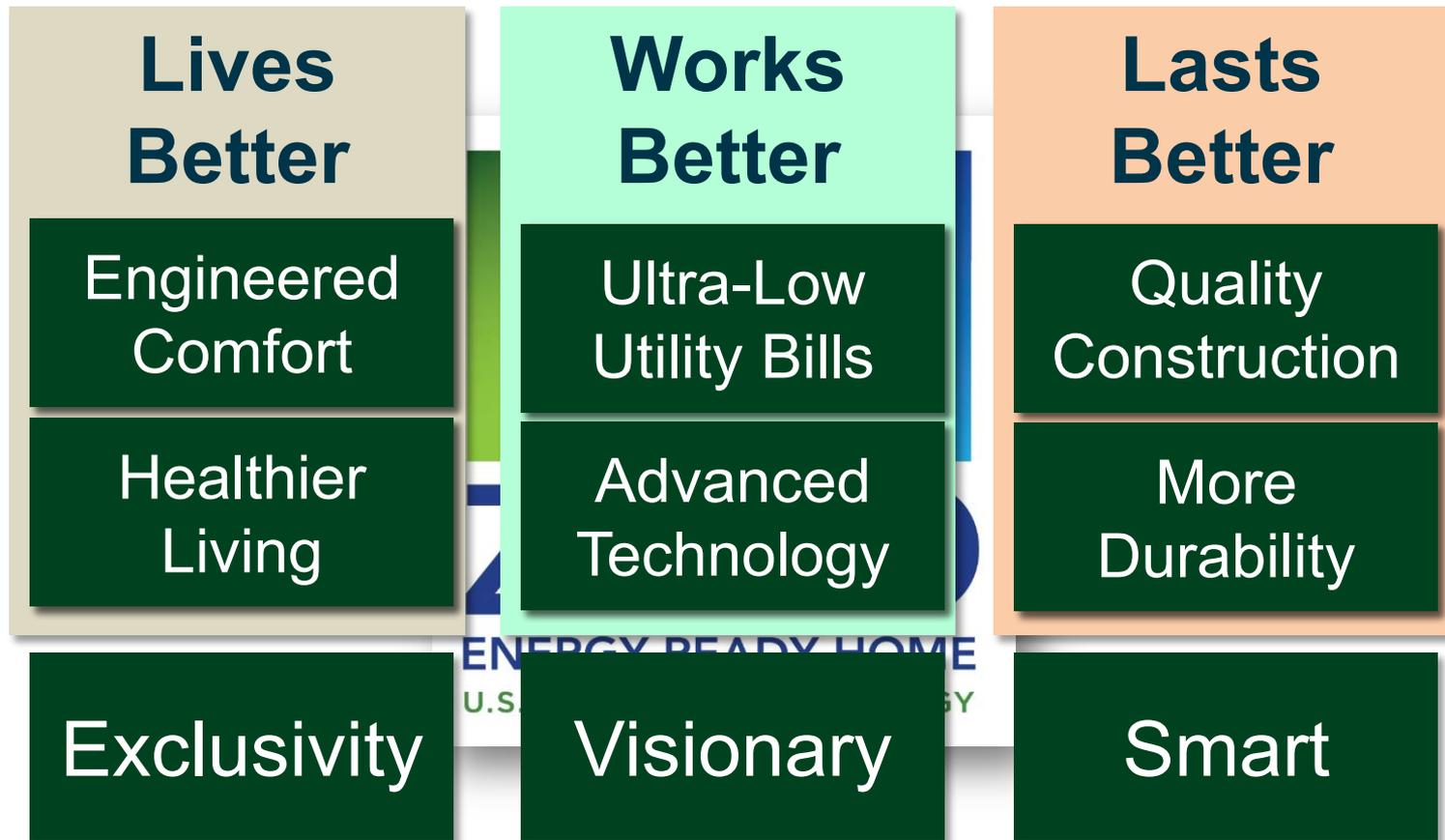
Zero Differentiation:

Efficient Components
Solar Ready Construction



High-performance
home, so
energy efficient,
all or most
annual energy
consumption
can be offset by
renewable energy.

Zero Energy Ready Home Value



ZERH Value is Clear



A Symbol of Excellence
Every Zero Energy Ready Home offers a cost-effective, high performance package of energy savings, comfort, health, and durability unparalleled in today's marketplace.



Lives Better

HEALTHFUL ENVIRONMENT

Every DOE Zero Energy Ready Home has a comprehensive package of measures to minimize dangerous pollutants, provide continuous fresh air, and effectively filter the air you breathe.

COMFORT PLUS

Superior insulation, windows, air sealing and space conditioning systems included in every DOE Zero Energy Ready Home surround you with even temperatures, low-humidity, and quiet in every room on every floor.

KEY

- DOE Zero Energy Ready Home
- ENERGY STAR Certified Home
- Existing Home



Works Better

ADVANCED TECHNOLOGY

Every DOE Zero Energy Ready Home begins with solid building science specified by ENERGY STAR for Homes, and then adds advanced technologies and practices from DOE's world-class research program, Building America.

ULTRA EFFICIENT

Compared to a typical home, an ultra efficient Zero Energy Ready Home is inexpensive to own. In fact, every DOE Zero Energy Ready Home is so energy efficient, a small solar electric system can easily offset most, or all, of your annual energy consumption. We call this Zero Net-Energy Ready.



Lasts Better

QUALITY BUILT

Advanced construction practices and technologies are specified for every DOE Zero Energy Ready Home. Then they are enforced by independent verifiers with detailed checklists and prescribed diagnostics.

DURABILITY

The advanced levels of energy savings, comfort, health, durability, quality and future performance in every DOE Zero Energy Ready Home provide value that will stand the test of time, and will meet and exceed forthcoming code requirements.

LEARN MORE AT: buildings.energy.gov/zero

The Future of Housing—Today

Only a select group of the top builders in the country meet the extraordinary levels of excellence and quality specified by U.S. Department of Energy guidelines.



LEARN MORE AT:
buildings.energy.gov/zero



A Symbol of Excellence

HEALTHFUL ENVIRONMENT

COMFORT PLUS

ADVANCED TECHNOLOGY

ULTRA EFFICIENT

QUALITY BUILT

DURABILITY

KEY

- DOE Zero Energy Ready Home
- ENERGY STAR Certified Home
- Existing Home

This label indicates relative performance of this DOE Zero Energy Ready Home to existing homes (built between 1990 and 2010) and ENERGY STAR Certified Homes. Actual performance may vary.



Front Cover

Inside Spread

Flap

Back Cover

New Town Builders Lives Better: **Healthful Environment**

**NEW
TOWN
BUILDERS**

- Fresh Air:
 - Supply Fresh Air System
 - Odor and Moisture Control Fans
 - High-Capture Filtration Technology
- Quiet:
 - Quiet Window Technology
 - Quiet Wall Technology
- Moisture Control:
 - Dry-by-Design Construction
 - Moisture Control System – Whole House
 - Moisture Controlled Comfort System
 - Moisture Controlled Windows
 - Moisture Controlled Lower Level
- Pest Control:
 - Bug Control Barrier
 - Pest Screened Home
- Outdoor Contaminant Control:
 - Contaminant Sealed Construction
 - Contaminant Sealed Comfort Delivery
 - Dust and Pollen Barrier
 - Radon Controlled Home
- Chemical Control:
 - Formaldehyde Controlled Home
 - VOC Controlled Home
- Fume Control:
 - Carbon Monoxide Controlled Equipment
 - Carbon Monoxide Controlled Fireplace
 - Fume Controlled Garage

ZERH Value is Clear & Simple!

U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy



**My power bill is \$5.
What's yours?**

- Heather Robbins, Garbett Homeowner

garbettHOMES.com
Now you're living.



How Can Uncle Sam Help?

**Innovation
Pipeline**

**Guidance &
Tools**

**Improved
Infrastructure**

**Market
Recognition**

Building America
R&D Roadmap

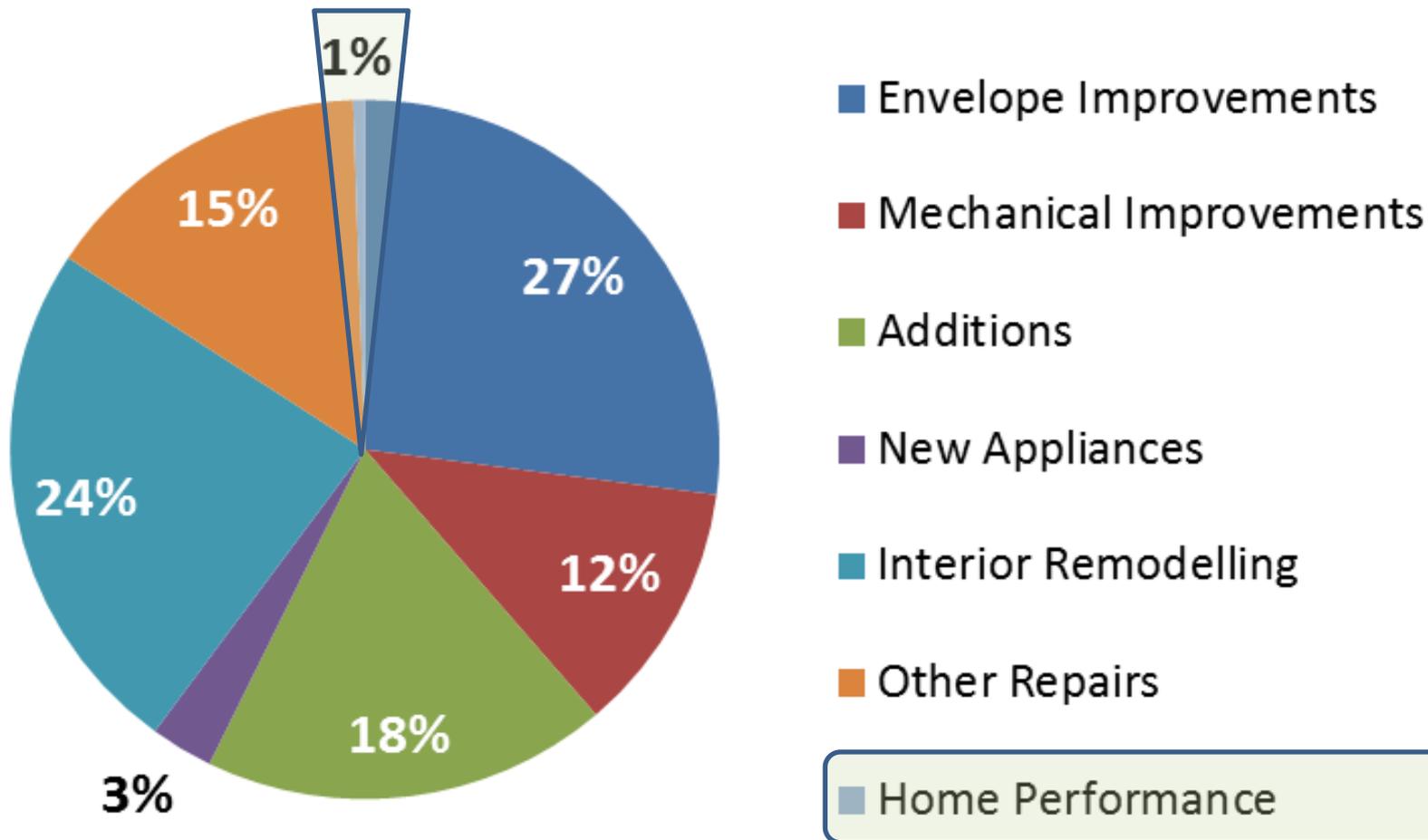
New Construction

**Existing Home
Improvement**

What's Next?



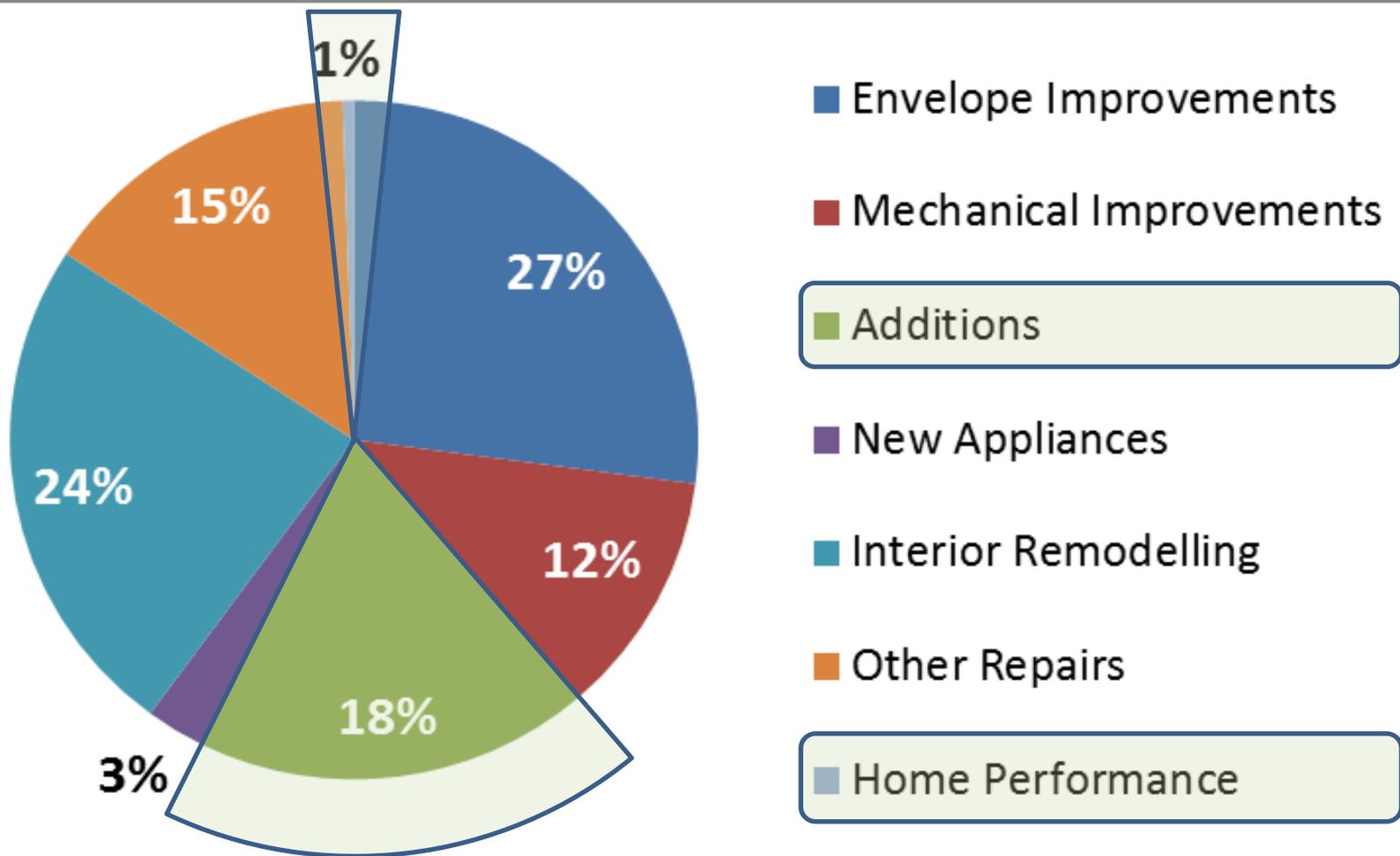
Home Improvement Industry Annual Revenues by Project Type



Existing homes path is not so clear

- We need a better link between New Construction technology advancement and existing home deployment – Remodeling **Additions** are the home improvement sector that provides a direct link.
- EPA Energy Star for Homes is the obvious starting point...
- But, **Additions** are still <20% of the Home Improvement market activity

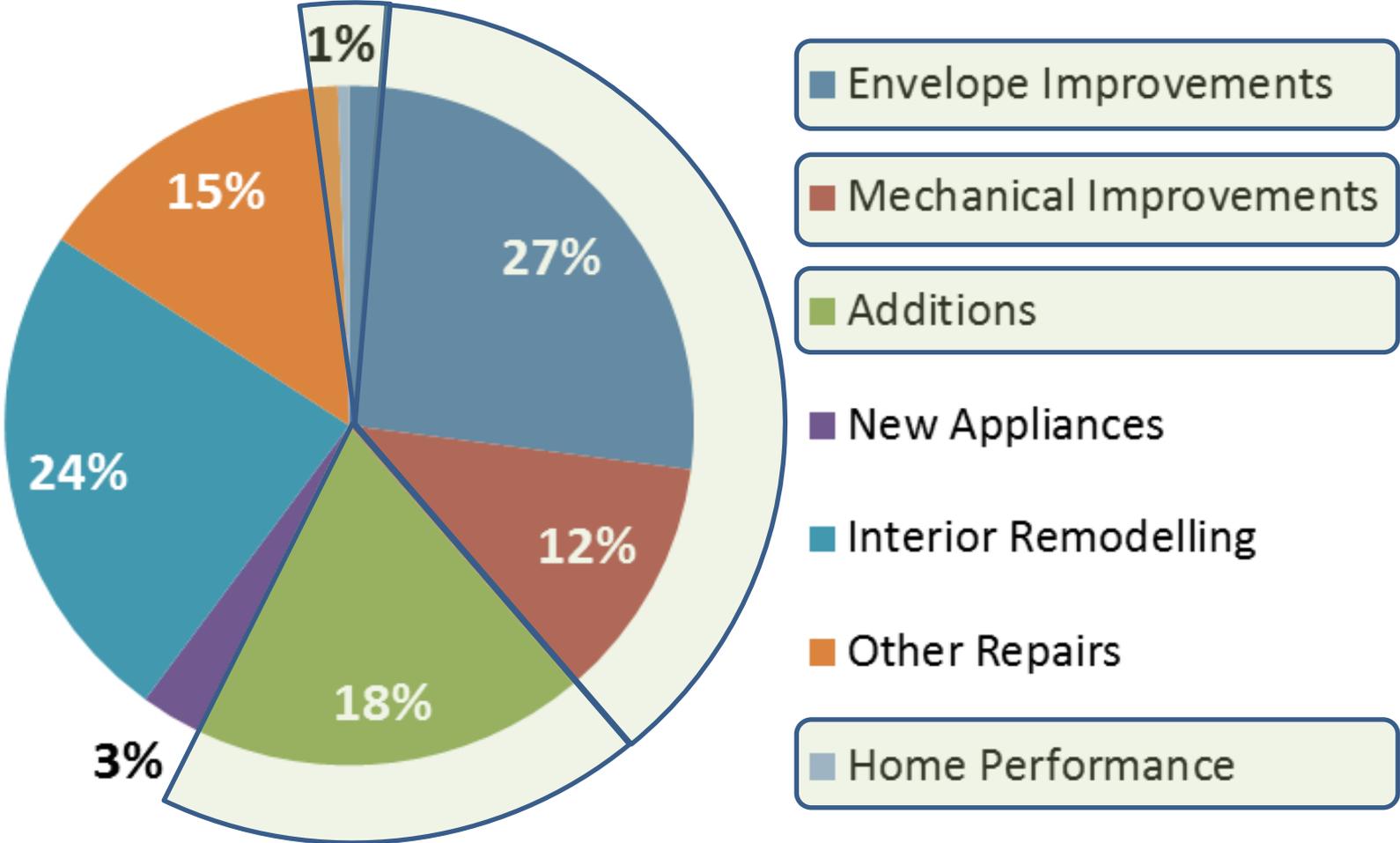
Home Improvement Industry Annual Revenues by Project Type



Existing homes path is not so clear

- We should also figure out how to improve home energy efficiency during these common transactions:
 - HVAC Replacements & Repairs
 - Envelope Improvements

Home Improvement Industry Annual Revenues by Project Type



Next Steps for Existing Homes?

Phase 1: HPC Market Creation

HPC Trade

Whole
House
Upgrades

Market: \$1B/yr
(~100k projects)
Cash/Finance

HPwES & HES

Strategy:

1) Establish market for WH energy upgrades; and 2) make savings visible

Next Steps???

Strategies to Address Home Improvement

HVAC

Water Heater

Mechanical
System
Upgrades

Market: \$15B/yr
(~3M projects)
Cash/Finance/LOC

E* + ducts

Push Strategy: 1) BBSC solutions for pgms/trades, 2) BASC specs & guidance for trades, 3) BS education for workforce, 4) BB peer network, and 5) performance label(s) for trades

Pull Strategy: 1) DOE upgrade recommendations for consumers, 2) BA performance validation - business case for trades, and 3) SUI pilot - policy case for programs

Windows

Siding

Roofing

Insulation

Envelope
Upgrades

Market: \$35B/yr
(~8M projects)
Cash/Finance/LOC

Insulate/Seal

Kitchen

Bath

Other

Additions

Market: \$15B/yr
(~1M projects)
Refinance/LOC

New Home specs

TRIGGER
EVENTS
(Trades)

Big box: DIY

Electrical

Appliances
& Lighting

Market: \$4B/yr
(~6M projects)
Cash

Raise Stds

Strategy:
1) Set DOE Appliance Stds, and 2) support E* Stds

Home Sale/
Purchase

Market: \$500B+
(~5M homes/yr)
Home Mortgage

WH upgrade

Strategy:
Big policy?
("Million Home Challenge")

How Can Uncle Sam Help?

Innovation
Pipeline

Guidance &
Tools

Improved
Infrastructure

Market
Recognition

Building America
Solution Center

Program
Specifications

Risk Management
Tools



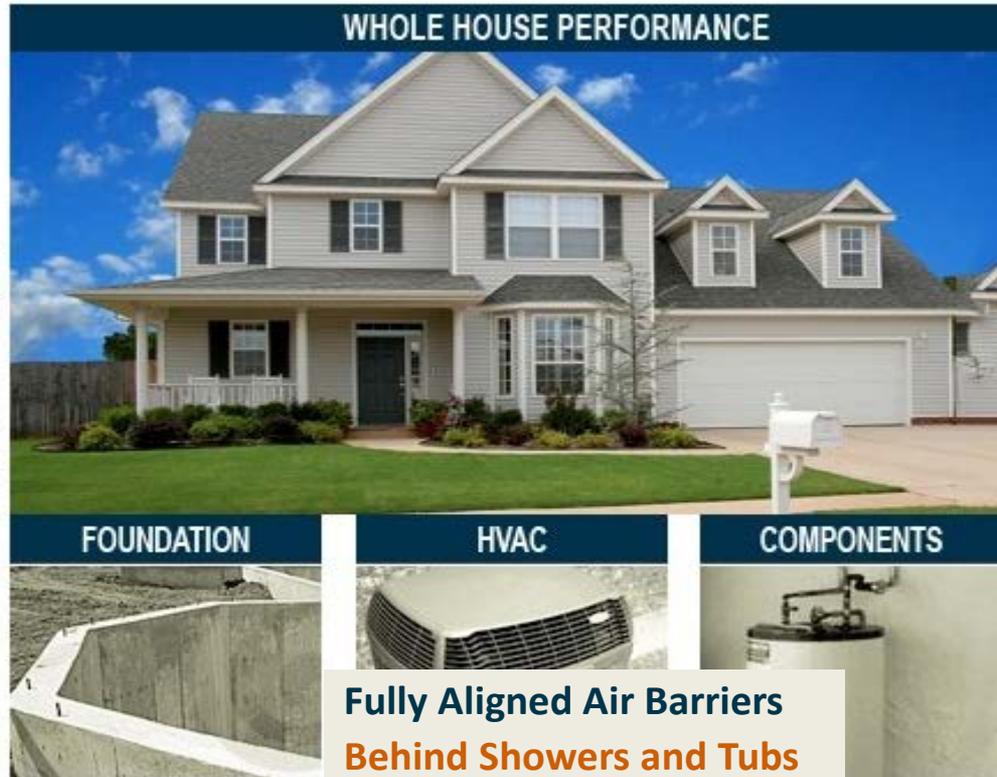
World-Class Expert Guidance...

Building America Solution Center
BASC.energy.gov



...At Your
Fingertips

BASC Component Explorer



ROOF/FLOOR/CEILING



WALLS/OPENINGS



FOUNDATION



HVAC



COMPONENTS



QA/QC



DESIGN



Walls/Openings
Water Managed Walls
Minimum Thermal Bridging
Insulation
Air Sealing
Fully Aligned Air Barriers

Fully Aligned Air Barriers
Behind Showers and Tubs
Behind Fireplaces
Attic Knee Walls
Skylight Shaft
Walls Adjoining Porch
Double Walls
Garage Rim/Band Joist

[Solution Center Home](#)

[Component Explorer](#)

[Checklist Manager](#)

[Building Science
Explorer](#)

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Attic Knee Walls

Please [Register](#) or [Login](#) to Provide Feedback.

Scope Description Ensuring Success Climate Training CAD Compliance More Info.

Scope

Fully Aligned Air Barrier

- A. Install a top and bottom plate or blocking at the top and bottom of all knee wall cavities.
- B. Back attic knee walls with a rigid air barrier or other supporting material to prevent insulation from sagging and create a continuous thermal barrier*
- C. Seal all seams, gaps, and holes of the air barrier with caulk or foam.
- D. Install insulation without misalignments, compressions, gaps, or voids in all knee wall cavities.



* ENERGY STAR recommends using a rigid air barrier, but it is not a requirement.

Notes:



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Scope: Clearly defines and bounds the topic in a way builders and remodelers can contractually obligate their subcontractors.

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Attic Knee Walls

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[Scope](#) [Description](#) [Ensuring Success](#) [Climate](#) [Training](#) [CAD](#) [Compliance](#) [More Info.](#)

Description

Knee walls, the walls that separate conditioned from unconditioned space in an attic, can be a source of significant air leakage if a continuous air barrier is not provided to prevent unconditioned air from flowing under the knee wall and under the floor boards of the attic room. There are two ways to block off this air flow: either a continuous air barrier can be provided from the top of the knee wall down to the attic floor, including the spaces between the attic floor joists from the bottom of the knee wall to the ceiling deck below, or a continuous air barrier can be installed from the top of the knee wall along the attic roofline to the top plate of the home's exterior wall. With either method the air barrier should be installed before installing attic floor insulation to the unconditioned portion of the attic. An air barrier is defined as any durable, solid material that blocks air flow between conditioned space and unconditioned space, including necessary sealing to block excessive air flow at edges and seams and adequate support to resist positive and negative pressures without displacement or damage. Air barrier material can include thin sheet goods such as rigid insulation, dry wall, OSB, plywood, or rolled batt insulation that is covered with spray foam. These materials may be installed by insulators, framers, or drywallers. This task should be included in the contract for the appropriate trade depending on the workflow at the specific job site.

Air barrier effectiveness is measured at the whole-house level. High-performance branding programs and the 2009 IECC require that builders meet specified infiltration rates at the whole-house level. See the "compliance" tab for these specified infiltration rates.



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Description: Provides an explanation of the building topic and in some cases specific "how-to" implementation steps.

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Attic Knee Walls

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Ensuring Success

Blower door testing, conducted as part of whole-house energy performance testing, may help indicate whether air leakage at knee walls has been successfully sealed. An infrared camera may also be used to determine air leakage at the knee wall, if a sufficient temperature difference exists between the attic and the conditioned space of the house to see the leakage. An experienced technician can also check for air leaks beneath the knee walls with a smoke pencil or by feeling for leaks with the back of the hand.



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Ensuring Success: Related health, safety, durability, performance issues, test-in/test-out requirements, and scheduling and sequencing considerations.

Solution Center Home

Component Explorer

Checklist Manager

Building Science
Explorer

Browser

Guides

CAD Files

Case Studies

Image Gallery

References

Attic Knee Walls

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Scope Description Ensuring Success **Climate** Training CAD Compliance More Info.

Climate

[ENERGY STAR Version 3. \(Rev. 6\)](#)
Thermal Enclosure Checklist, Fully-Aligned Air Barriers. A complete air barrier shall be provided that is fully aligned with the insulation at exterior surface of walls in all climate zones; and also at interior surface of walls for Climate Zones 4-8.

[DOE Challenge Home](#)
Exhibit 2: DOE Challenge Home Target Home. Infiltration (ACH50): Zones 1-2: 3; Zones 3-4: 2.5; Zones 5-7: 2; Zone 8: 1.5. Envelope leakage shall be determined by an approved verifier using a RESNET-approved testing protocol.





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Climate: Climate-specific codes, standards, ENERGY STAR, and Challenge Home guidance.

- Solution Center Home
- Component Explorer
- Checklist Manager
- Building Science Explorer
- Browser
 - Guides
 - CAD Files
 - Case Studies
 - Image Gallery
 - References

Attic Knee Walls

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Scope Description Ensuring Success Climate **Training** CAD Compliance More Info.

Right and Wrong Images



Presentations
None Available

Videos



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Training: resources such as Right and Wrong/ Sequencing installation images.

COMING: Videos and presentations

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[Component Explorer](#)

[Checklist Manager](#)

[Building Science Explorer](#)

[Browser](#)

[Guides](#)

[CAD Files](#)

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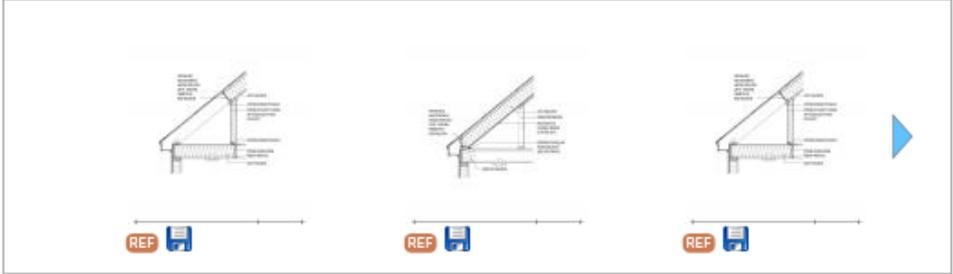
[References](#)

Attic Knee Walls

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Scope Description Ensuring Success Climate Training **CAD** Compliance More Info.

CAD Images



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CAD: Architectural CAD files of the building topic in DWG and PDF forms.

Solution Center Home

Component Explorer

Checklist Manager

Building Science
Explorer

Browser

Guides

CAD Files

Case Studies

Image Gallery

References

Attic Knee Walls

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Scope Description Ensuring Success Climate Training CAD **Compliance** More Info.

Compliance

[ENERGY STAR Version 3, \(Rev. 6\)](#)
Thermal Enclosure Checklist, Fully-Aligned Air Barriers. A complete air barrier shall be provided that is fully aligned with the insulation at exterior surface of walls in all climate zones; and also at interior surface of walls for Climate Zones 4-8. All insulated vertical surfaces are considered walls (e.g., above and below grade exterior walls, knee walls) and must meet the air barrier requirements for walls, with the exception of adiabatic walls in multifamily dwellings.

[DOE Challenge Home](#)
Exhibit 2: DOE Challenge Home Target Home. Certified under ENERGY STAR Qualified Homes Version 3. Infiltration (ACH50): Zones 1-2: 3; Zones 3-4: 2.5; Zones 5-7: 2; Zone 8: 1.5. Envelope leakage shall be determined by an approved verifier using a RESNET-approved testing protocol. Building envelope assemblies, including exterior walls and unvented attic assemblies (where used), shall comply with the relevant vapor retarder provisions of the 2012 International Residential Code.

[ASTM E1677-11](#)
Standard Specification for Air Barrier (AB) Material or System for Low-Rise Framed Building Walls. This specification covers minimum performances and specification criteria for an air barrier material or system for framed, opaque walls of low-rise buildings. The provisions are intended to allow the user to



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Compliance: Specific compliance references/links from applicable codes and standards.

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Attic Knee Walls

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Scope Description Ensuring Success Climate Training CAD Compliance **More Info.**

Case Studies

- David Weekley Homes: Eagle Springs & Waterhaven, Houston, TX**
PNNL. 2012. Building America Case Study: David Weekley Homes, Eagle Springs & Waterhaven, Houston, TX, PNNL-SA-87333, prepared by the Pacific Northwest National Laboratory for the U.S. Department of Energy.
[Link to Document](#) 
- Tommy Williams Homes: Longleaf Village & Belmont, Gainesville, FL**
PNNL. 2012. Building America Case Study: Tommy Williams Homes, Longleaf Village & Belmont, Gainesville, FL, PNNL-SA-87331, prepared by the Pacific Northwest National Laboratory for the U.S. Department of Energy.
[Link to Document](#) 

References

- [2009 IECC—International Energy Conservation Code](#)
2009 IECC, International Energy Conservation Code. International Code Council, Washington.



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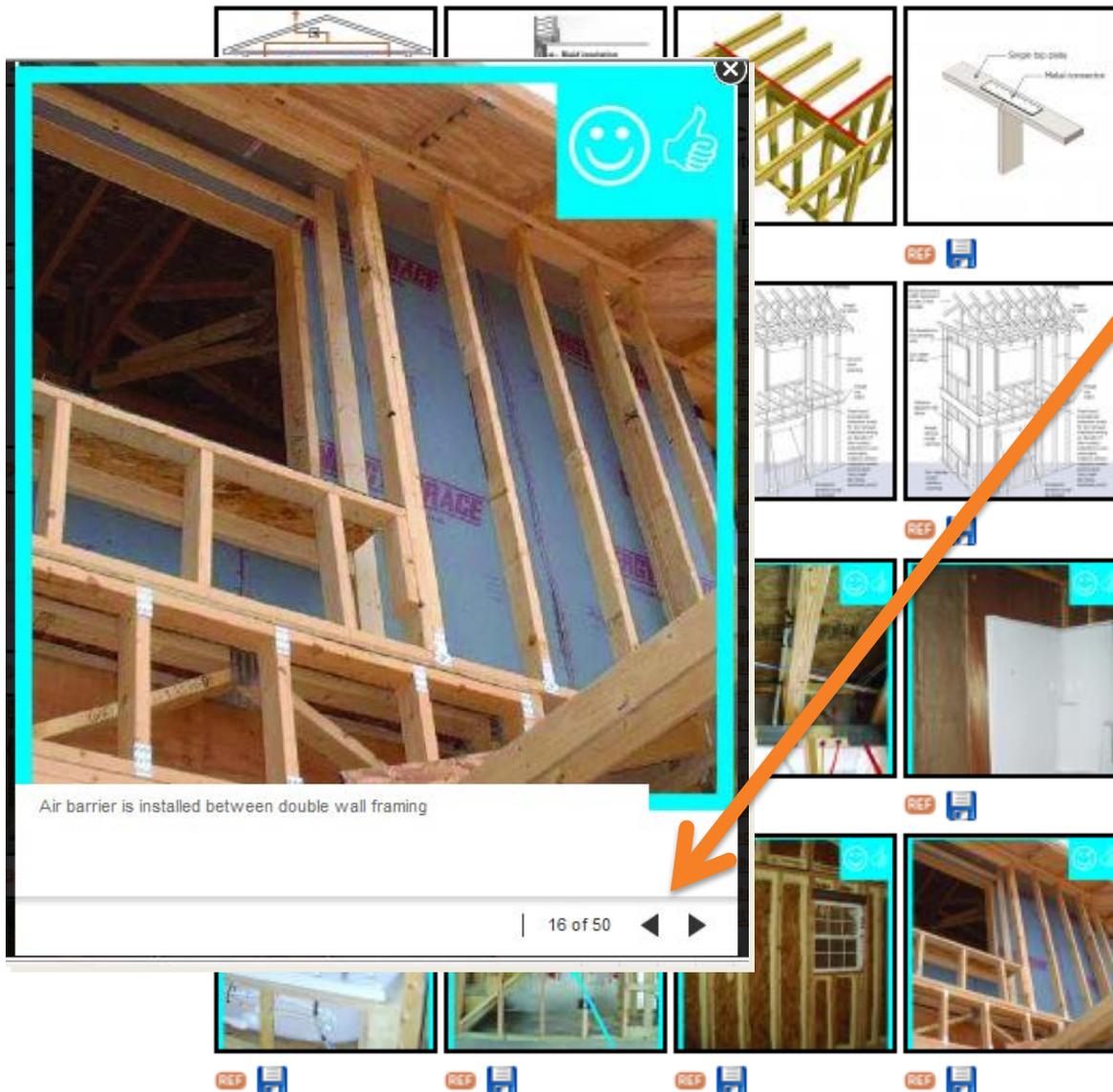
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More Info:

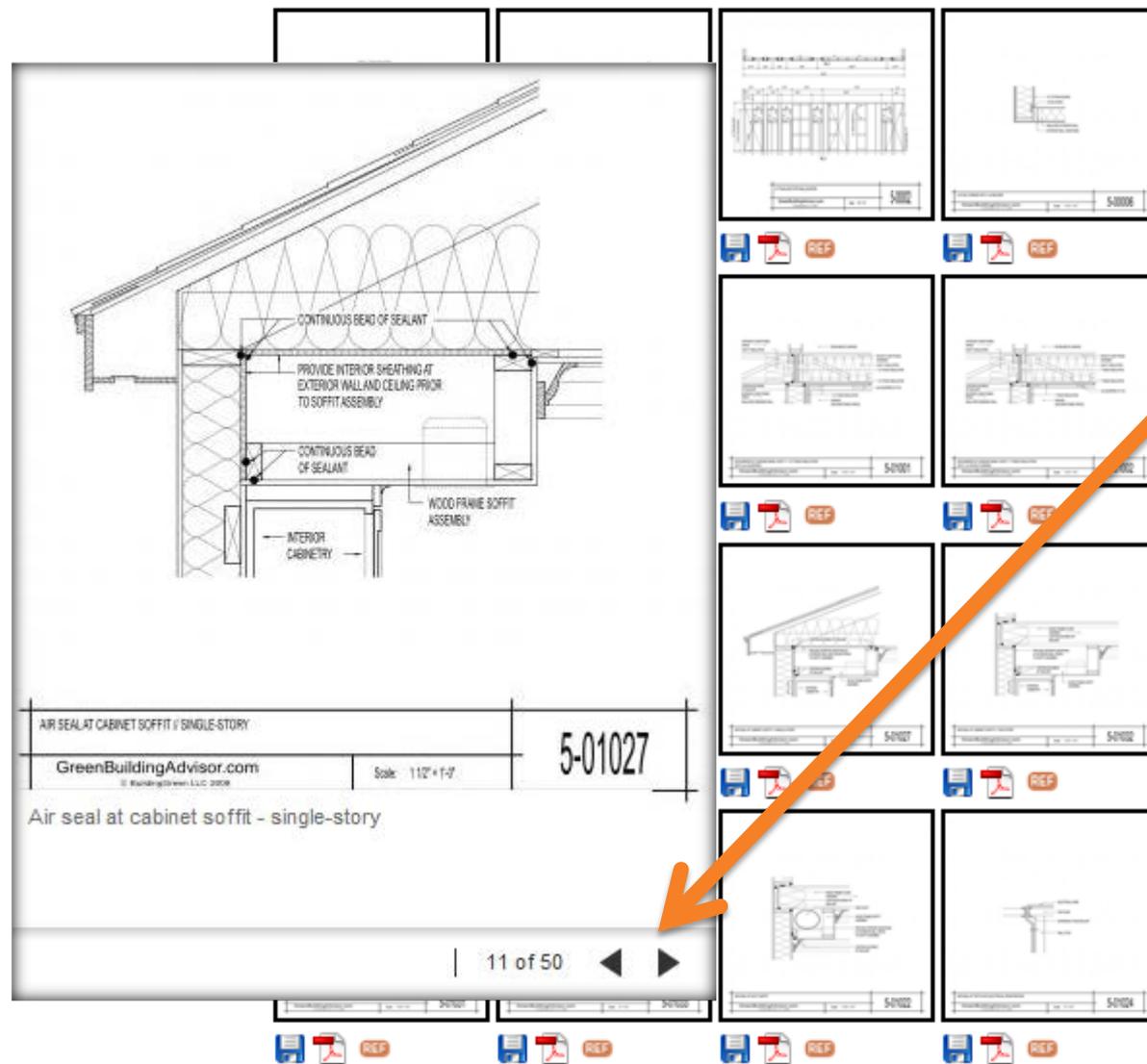
- References - Full citations with links for content
- Case Studies - Whole-house best practices
- Resources - Relevant info not previously cited

BASC Browser Image Gallery



- Click an image to enlarge in a sliding window.

BASC Browser Cad Files

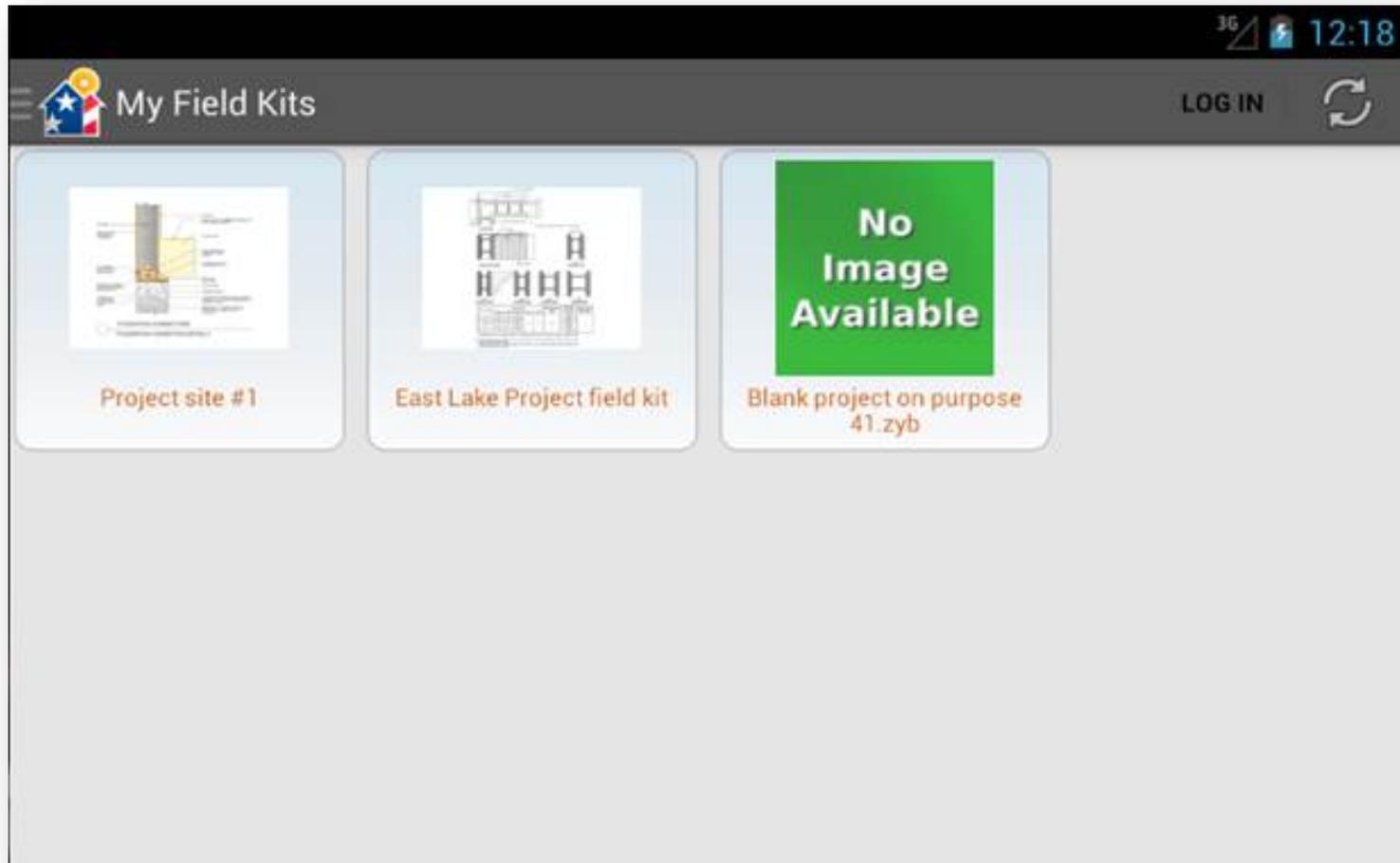


- Click the CAD file image to load in a slider window.

BASC Mobile Application



BASC Mobile Application



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Building Science
Publications

Program Checklists



ENERGY STAR Qualified Homes, Version 3 (Rev. 6) Checklist into the Checklist Manager. Additional ENERGY STAR program requirements and information can be found at the [ENERGY STAR Website](#).



DOE Challenge Homes National Program Requirements (Rev. 02). DOE Challenge Home offers both a Prescriptive Path and Performance Path to meet program requirements. Additional information can be found at the [DOE Challenge Home Website](#).



EPA's Indoor airPLUS Program checklist helps builders construct homes with improved indoor air quality. This checklist is a component of the Challenge Home Checklist. Additional information can be found at the [EPA Indoor airPLUS Program Website](#).



The Renewable Energy Ready Home Solar Photovoltaic Checklist was designed for builders constructing single family homes with pitched roofs. This checklist is a component of the Challenge Home Checklist. Additional information can be found at the [EPA Renewable Energy Ready Homes Website](#).



The Renewable Energy Ready Home Solar Water Heating Checklist was designed for builders constructing single family homes with pitched roofs. This checklist is a component of the Challenge Home Checklist. Additional information can be found at the [EPA Renewable Energy Ready Homes Website](#).

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DOE Challenge Home Program Requirements (Rev. 02)



The Building America Solution Center has integrated the DOE Challenge Homes National Program Requirements (Rev. 02) into the Program Checklists. Use the boxes to access specific parts of the Requirements, which have been numbered and titled to be consistent with the DOE Challenge Home National Program Requires. Additional information can be found at the [DOE Challenge Home Website](#).

Exhibit 1: Mandatory Requirements for All Labeled Homes

- ▶ 1. ENERGY STAR for Homes Baseline
 - Confirmed under ENERGY STAR Qualified Homes Version 3.0
- ▶ 2. Energy Performance
- ▶ 3. Duct System
- ▶ 4. Water Efficiency
- ▶ 5. Lighting & Appliances
- ▶ 6. Indoor Air Quality
 - EPA Indoor airPLUS Verification Checklist and Construction Specifications
 - Alternative: ENERGY STAR for Homes V3 Water Management System Builder Checklist
- ▶ 7. Renewable Ready
 - Consolidated Renewable Energy Ready Checklist

Exhibit 2: Target Home

- ▶ HVAC Equipment
- ▶ Insulation and Infiltration
- ▶ Windows
- ▶ Water Heater
- ▶ Thermostat
- ▶ Lighting & Appliances

Exhibit 3: Benchmark Home Size

- ▶ Benchmark Home Size

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Indoor airPLUS Qualified Homes Program Requirements



EPA's Indoor airPLUS Program checklist helps builders construct homes with improved indoor air quality. This checklist is a component of the Challenge Home Checklist. Additional information can be found at the [EPA Indoor airPLUS Program Website](#).

▶ **ENERGY STAR for Homes Baseline**

- Thermal Enclosure System Rater Checklist completed.
- HVAC System Quality Installation Contractor Checklist completed.
- HVAC System Quality Installation Rater Checklist completed.
- Water Management System Builder Checklist completed.

▶ **Moisture Control**

▶ **Radon**

▶ **Pests**

▶ **HVAC Systems**

▶ **Combustion Pollutants**

▶ **Materials**

▶ **Final**

The screenshot shows the 'Building America Solution Center' page. At the top, there is a navigation bar with the U.S. Department of Energy logo and 'Energy Efficiency & Renewable Energy' text. On the right, there are 'Login' and 'Register' links, a search input field, and a 'SEARCH' button. Below the navigation bar, the page title is 'Building America Solution Center'. A breadcrumb trail reads 'EERE » BTQ » Building America » Solution Center » Checklists'. The main content area is titled 'ENERGY STAR Qualified Homes, Version 3 (Rev. 06)'. To the left is a sidebar with a 'Component Explorer' menu containing 'Checklist Manager', 'ENERGY STAR', 'Building Science Explorer', and 'Browser'. The 'Checklist Manager' section is active. The main text area contains a paragraph explaining that the Checklist Manager provides links to technical guides for ENERGY STAR Qualified Homes, Version 3 (Rev. 6). It mentions that the numbers and titles follow the same order as the four ENERGY STAR Inspection Checklists for National Program Requirements. It also refers to 'program checklists' and 'programmatic footnotes'. An orange arrow points to the first item in a list: 'Thermal Enclosure System Rater Checklist (TES)'. Other items in the list include 'HVAC System Quality Installation Contractor Checklist (HVAC/C)', 'HVAC System Quality Installation Rater Checklist (HVAC/R)', and 'Water Management System Builder Checklist (WMS)'. At the bottom of the page, there are links for 'Contact Us', 'Web Site Policies', 'U.S. Department of Energy', and 'USA.gov', along with the text 'Content Last Updated: 12/13/2012'.

The screenshot shows the 'Building America Solution Center' page. At the top left is the U.S. Department of Energy logo and 'Energy Efficiency & Renewable Energy'. On the right, there are 'Login' and 'Register' links and a search bar with a 'SEARCH' button. The main heading is 'Building America Solution Center'. Below it is a breadcrumb trail: 'EERE » BTO » Building America » Solution Center » Checklists'. A left sidebar contains navigation links: 'Solution Center Home', 'Component Explorer', 'Checklist Manager' (highlighted), 'ENERGY STAR', 'Building Science Explorer', 'Browser', 'Guides', 'CAD Files', 'Case Studies', 'Image Gallery', and 'References'. The main content area features the 'ENERGY STAR Qualified Homes, Version 3 (Rev. 06)' section with the ENERGY STAR logo and a paragraph of text. Below this is a list of checklists under a 'Thermal Enclosure System Rater Checklist (TES)' header, including 'TES 1. High-Performance Fenestration', 'TES 2. Quality-Installed Insulation', 'TES 3. Fully-Aligned Air Barriers', 'TES 4. Reduced Thermal Bridging', and 'TES 5. Air Sealing'. Other checklists listed are 'HVAC System Quality Installation Contractor Checklist (HVAC/C)', 'HVAC System Quality Installation Rater Checklist (HVAC/R)', and 'Water Management System Builder Checklist (WMS)'. An orange arrow points to 'TES 3. Fully-Aligned Air Barriers'. At the bottom, there are links for 'Contact Us', 'Web Site Policies', 'U.S. Department of Energy', and 'USA.gov', along with the text 'Content Last Updated: 12/13/2012'.

The screenshot shows the BASC Checklist Manager web application. At the top, there is a navigation bar with the U.S. Department of Energy logo and the text "Energy Efficiency & Renewable Energy". Below this, the page title "Building America Solution Center" is displayed. A search bar with a "SEARCH" button is located in the top right corner. The main content area is titled "ENERGY STAR Qualified Homes, Version 3 (Rev. 06)". On the left side, there is a sidebar menu with options like "Solution Center Home", "Component Explorer", "Checklist Manager", "Building Science Explorer", "Browser", "Guides", "CAD Files", "Case Studies", "Image Gallery", and "References". The "Checklist Manager" section is active, showing a list of checklists under the heading "Thermal Enclosure System Rater Checklist (TES)". The list includes "TES 1. High-Performance Fenestration", "TES 2. Quality-Installed Insulation", and "TES 3. Fully-Aligned Air Barriers". Under "TES 3. Fully-Aligned Air Barriers", there are sub-sections for "Walls", "Floors", and "Ceilings". An orange arrow points to the "TES 3.1.3. Attic knee walls" item.

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ENERGY STAR Qualified Homes, Version 3 (Rev. 06)

Checklist Manager provides links to technical guides that align with each measure included in the checklists for ENERGY STAR Qualified Homes, Version 3 (Rev. 06). The numbers and titles included in the Checklist Manager follow the same order as the four ENERGY STAR Inspection Checklists for National Program Requirements. To view programmatic footnotes, see the original [program checklists](#). Portions of the programmatic footnotes have been added to the Scope tabs in the guides. For additional ENERGY STAR program requirements and information, visit the [ENERGY STAR Website](#).

Thermal Enclosure System Rater Checklist (TES)

- TES 1. High-Performance Fenestration
- TES 2. Quality-Installed Insulation
- TES 3. Fully-Aligned Air Barriers
 - TES 3.1. Walls
 - TES 3.1.1. Walls behind showers and tubs
 - TES 3.1.2. Walls behind fireplaces
 - TES 3.1.3. Attic knee walls
 - TES 3.1.4. Skylight shaft walls
 - TES 3.1.5. Wall adjoining porch roof
 - TES 3.1.6. Staircase walls
 - TES 3.1.7. Double walls
 - TES 3.1.8. Garage rim / band joist adjoining conditioned space
 - TES 3.1.9. All other exterior walls
 - TES 3.2. Floors
 - TES 3.2.1. Floor above garage
 - TES 3.2.2. Cantilevered floor
 - TES 3.2.3. Floor above unconditioned basement or unconditioned crawlspace
 - TES 3.3. Ceilings
 - TES 3.3.1. Dropped ceiling / soffit below unconditioned attic
 - TES 3.3.2. All other ceilings

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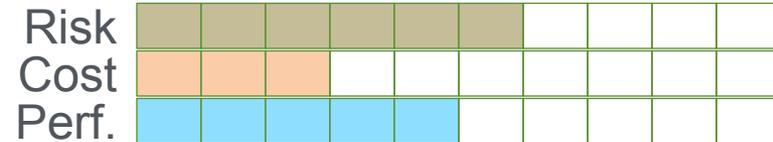
Latest concept from the ...



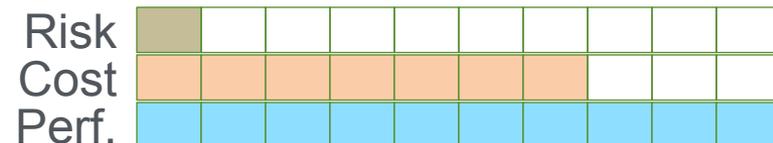
Thermal Enclosure Options: Walls Climate Zones 6-7

The following guidance for selecting wall assemblies is based on research from the DOE Building America program. Risk is based on degree of moisture management issues associated with each assembly. Cost is based on research of post-learning curve experiences with production builders. And performance is based on the energy savings results with detailed modeling analyses.

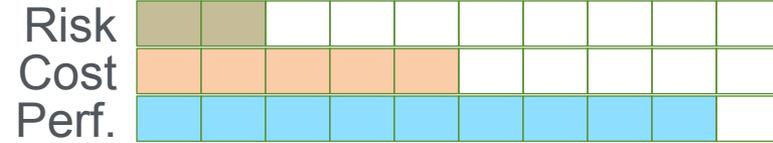
Advanced Framing



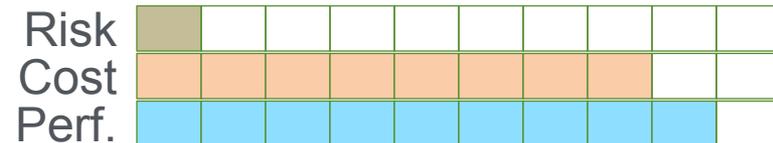
Exterior Rigid Insulation
With Advanced Framing



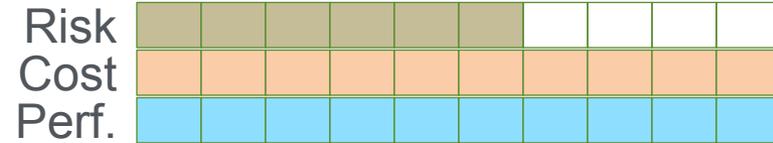
Exterior Rigid Insulation
Extended Plate and Beam



Structural Insulated Panel



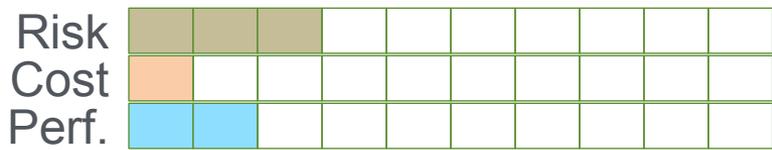
Double-Wall Construction



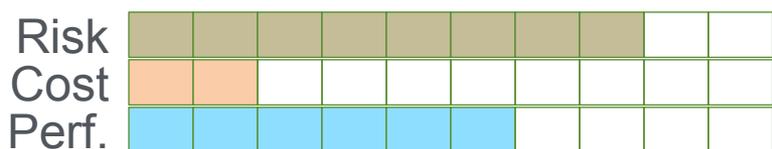
IAQ: Whole-House Ventilation Climate Zones 6-7

The following guidance for selecting ASHRAE 62.2 compliant whole-house ventilation is based on research from the DOE Building America program. Risk is based on degree of IAQ issues associated with each option. Cost is based on research of post-learning curve experiences with production builders. And performance is based on the energy of effective dilution through-out home and persistence.

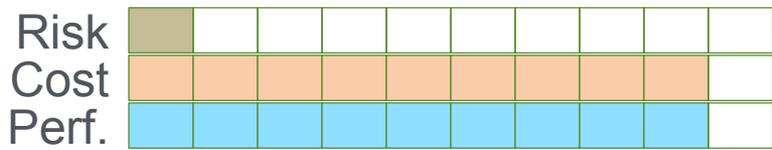
Exhaust Only Fan



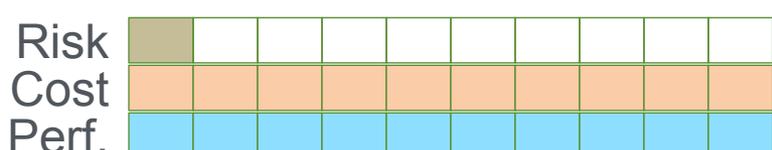
Central Fan Integrated System with Controller



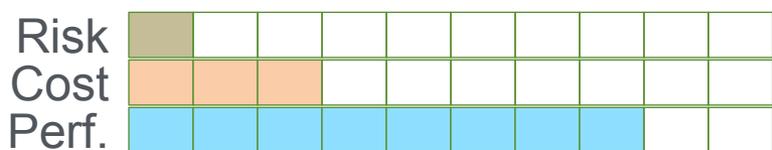
Heat Recovery Ventilation (HRV)



Energy Recovery Ventilation (ERV)



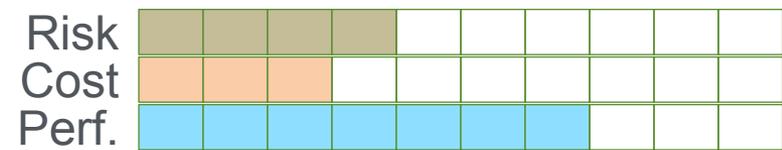
Combined Exhaust Only and CFIS System



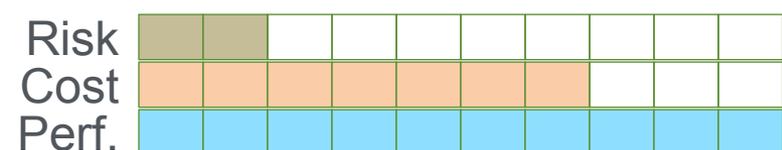
Optimized Low-Load Comfort System Hot-Humid/Warm-Humid

The following guidance for selecting comfort systems is based on research from the DOE Building America program. Risk is based on potential for comfort complaints by occupants. Cost is based on research of post-learning curve experiences with production builders. And performance is based on effective mixing of air that provides control of heat, cooling, and relative humidity.

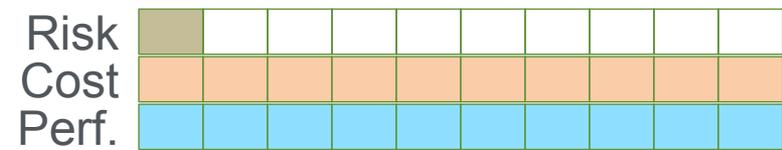
Two-Speed Heat Pump



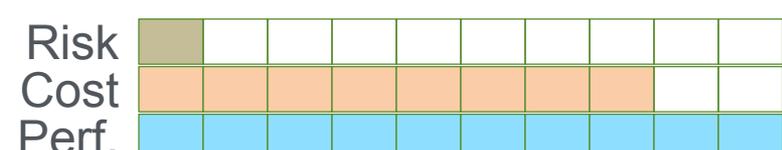
Variable-Speed Heat Pump



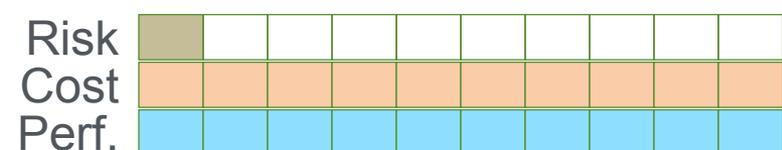
Variable-Speed Heat Pump
with CFIS & Dehumidifier



Variable –Speed High-Velocity Heat Pump



Variable-Speed Gas
Furnace/AC & Dehumidifier



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- ***Building America R&D projects validate high performance alternatives, addressing:***
 - Fire Code issues
 - Vapor Barrier issues in Building Codes
 - Ventilation Standard issues
- ***Building America R&D Roadmaps will address codes and standards barriers:***
 - Remaining Building Code issues
 - Next generation Ventilation Standard
 - Design Standard issues
 - Etc.

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Recognition



Engage college students across the U.S.
to integrate building science in design projects
so they are better prepared for the future...

zero energy buildings.

- Annual competition
- Teams sponsored by a collegiate institution
- At least three students and a faculty advisor
- Multidisciplinary team with industry advisor(s)
- Options:
 - redesign existing floor plan, or
 - create a new house design to project requirements
- Design target is DOE Zero Energy Ready Home

- Cost-effective from the buyer's perspective
{P-I-T-I-U-M}
- Demonstrate integration of building science principles
- Take Building Science Course or online course and pass online test

2015:

- 33 Universities
- 40 Teams
- Including Canada, China, & Norway teams
- Carl Franklin Homes committed to build winning designs

2014:

- 340+ Students
- 26 Universities
- 28 Teams

Thank You



For More Information:

<http://energy.gov/eere/buildings/building-america>

<http://energy.gov/eere/buildings/us-department-energy-race-zero-student-design-competition>